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DOMINION OF CANADA—DEPARTMENT OF AGRICULTURE

SOYBEANS

by

F. DIMMOCK

DIVISION OF FORAGE PLANTS
EXPERIMENTAL FARMS SERVICE

...ed by authority of the Hon. JAMES G. GARDINER, Minister of Agriculture
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...-12:39

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SOYBEANS

The soybean is a native of Asia, where it has been of great economic importance for at least 5,000 years. It has been grown in Canada to a limited but increasing extent in recent years, and gives every indication of becoming a valuable addition to the list of field crops. The area devoted to the crop in 1938 probably did not exceed 20,000 acres, nearly all of which was in the province of Ontario. Small patches are being grown in Nova Scotia, Quebec, southern Manitoba and British Columbia. At the present time, investigations are under way in practically all provinces to determine the possibilities of the soybean in the various parts of the Dominion.

Present production of the soybean in Canada is chiefly for seed, which, being extremely rich in protein and oil has a high value for both commercial and feed purposes. The industrial uses to which it can be put are very numerous. In the development of industrial uses for agricultural products, the soybean now occupies a prominent place in many countries. The seed also has considerable value on the farm for live stock feeding and since the soybean plant itself possesses a high nutritive value for fodder, it is quite possible that as production increases the crop may find its greatest use on the farm, rather than in industry.

The Dominion Department of Agriculture during the past fifteen years has introduced and tested hundreds of varieties and strains of soybeans from various parts of the world. Through selection and breeding several new varieties have been obtained which are well adapted to a wide range of conditions throughout the country. While it is true that soybeans have a much more limited adaptation in Canada than in the United States, where approximately 5,000,000 acres are being grown, the development of these new and better adapted varieties will constantly enlarge the area throughout the Dominion in which this crop can be successfully produced.

Since the soybean is comparatively new as a farm crop in Canada this pamphlet is intended to give information as to the characteristics of the soybean plant and seed; its adaptation to soil and climatic conditions; the various purposes for which soybeans are used; the most suitable varieties that are available; and general instructions on how the crop should be grown and handled.

Description of the Soybean Plant

The soybean is an annual plant belonging to the family Leguminosae. It has an erect, bushy, habit of growth, and varies in height from one to five feet according to variety and season. The stems, leaves, and pods are covered with fine, short hairs. In some varieties growth at the tips is so slender that there is a tendency towards vining for support. Branching occurs at the lower nodes and varies in amount in different varieties and seasons, and under different conditions of growth. The type of branching may be described as erect, mid-erect, spreading, or spreading widely. In the latter types especially, there is a tendency for splitting to occur at the point of attachment of the lower branches to the main stem, causing them to lodge on the ground. This, to some extent at least, appears to be a varietal characteristic, although unfavourable weather during a season of heavy growth may bring about this condition in almost any variety.

The soybean is normally self-fertilized. Natural crossing occurs to a limited extent but conclusions reached by numerous workers place the amount at considerably less than one per cent. The flowers are small and usually

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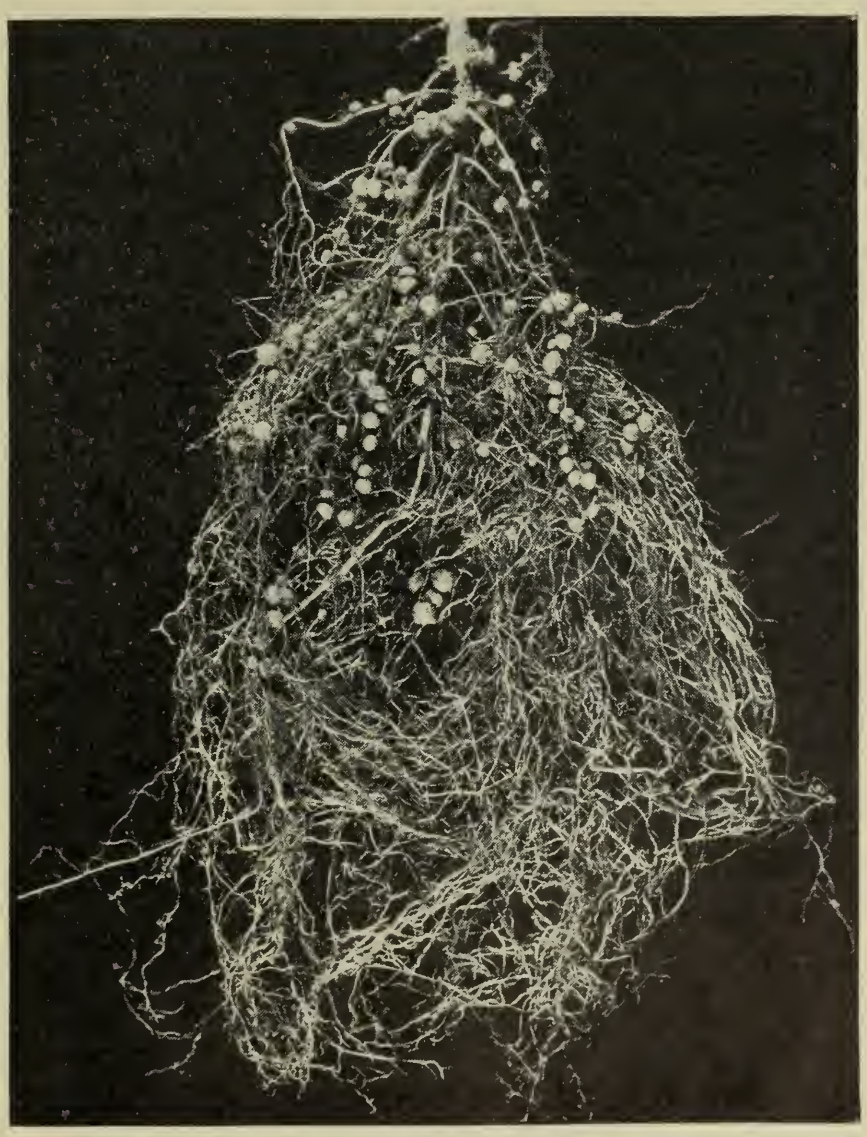
either white or purple in colour, and are borne in axillary clusters. The flowering period of a single plant is comparatively short, hence all of the pods develop and mature at approximately the same time. The pods bear from one to four seeds and their shape and size depends upon the number, shape

A mature soybean plant of good type.

and size of the seeds contained. The seed varies in shape from round to elliptical according to variety. Variety also determines the colour of the seed, which may be yellow, green, brown or black, or various combinations of these, and in the case of yellow or green seed may have either brown or black hilums. Under certain conditions yellow seed may show brown or black mottling, the cause of which so far, has not been definitely established. Undoubtedly environment and heredity both have a definite influence on mottling. The seed may be lost by shattering, either before or after harvest, through bursting of the pods. This is an objectionable feature and to some extent a varietal characteristic. The amount of shattering is influenced by the nature of the weather at the time it is likely to occur.

The leaves of the soybean are trifoliate, and with the exception of being more or less pointed at both ends, are generally egg-shaped or triangular, with the greatest width towards the base. They vary in size to some extent depending upon variety. In the great majority of varieties the leaves turn yellow and drop off as the plant approaches maturity.

The soybean develops a strong tap-root with numerous branching rootlets. A good supply of nodules develop under suitable conditions of growth, provided the necessary bacteria are either already present in the soil or are supplied by direct inoculation of the seed.



Root of a soybean plant, showing presence of nodules.

Soil and Climatic Adaptation

The soybean is adapted to a wide range of soil types but does best on sandy loam or clay loam. Generally speaking the soil requirements are similar to those for corn. A soil too acid for clover will often produce a good crop of soybeans.

The variation in maturity of soybean varieties gives the crop a fairly wide climatic adaptation. In general, the early maturing varieties require approximately the same seasonal conditions as early varieties of flint and dent corn while the late varieties are adapted to conditions in which the late flints and dents are successfully produced.

Uses of Soybean Seed

The mature seed of the soybean plant is valuable on the farm for feeding to live stock, while commercially it has a multiplicity of uses which are constantly being extended. It contains on the average 30 to 40 per cent of protein, 15 to 20 per cent of oil and 25 to 30 per cent nitrogen-free extract, starch being almost entirely absent. Composition of the seed of any one variety appears to be influenced considerably by the environment in which it is produced.

Soybean seed is a protein concentrate. It is a valuable source of protein in the grain rations of dairy cattle, beef cattle, sheep and brood sows. It should not be fed to market hogs in any quantity, as the high oil content of the seed produces soft carcasses. For dairy cattle the seed should be ground, but for other live stock the whole beans are satisfactory. Very good results have been reported from feeding the mature seed in the sheaf, thereby eliminating the cost of threshing and grinding. Frequently the seed is ground, together with the pods and stems, and fed in the form of a meal. It is a distinct advantage to be able to feed the beans whole, since there is a tendency for the ground beans to become rancid on standing. Owing to the difficulty of grinding soybeans alone, due to the high oil content, the seed should first be mixed with corn, oats or barley. It is usually recommended that the soybeans constitute about 20 per cent of the grain mixture for dairy cattle. Feeding trials indicate that soybeans may satisfactorily replace linseed or cottonseed meal as a source of protein for cattle and hogs. The results obtained from feeding whole or ground soybeans to poultry have not been very satisfactory. Soybean meal on the other hand is an excellent protein concentrate for poultry. Both soybean seed and soybean meal need to be supplemented with a suitable mineral mixture when fed to either poultry or hogs.

The following table[1] gives the digestible nutrients in 100 pounds of soybean seed and meal and other high protein concentrates, with their nutritive ratios (barley and oats[2] are included for comparison).

Feed	Crude Protein	Carbo-hydrates	Fat	Total	Nutritive ratio
	lb.	lb.	lb.	lb.	
Soybean seed	33·2	24·7	16·1	94·1	1 : 1·8
Soybean meal	39·7	34·7	4·5	84·5	1 : 1·1
Linseed meal	30·2	32·6	6·7	77·9	1 : 1·6
Cottonseed meal (prime)	33·4	24·3	7·9	75·5	1 : 1·3
Barley	9·0	66·8	1·6	79·4	1 : 7·8
Oats	9·7	52·1	3·8	70·4	1 : 6·3

[1]From "Soybeans in Minnesota", University of Minnesota, Spec. Bull. 134, 1930.

[2]Henry & Morrison, "Feeds & Feeding".

In the Orient the soybean is used very extensively for human food. Although the mature seed may be prepared similar to navy or field beans, generally speaking they are rather more difficult to cook. In the green stage, at the time when the beans have become fully developed, they may be used as a vegetable similar to the green pea or lima bean. Boiling the pods for several minutes facilitates the shelling of the beans.

Soybean Oil.—Soybean oil is extracted from the mature beans at the oil mills either by pressure or by the use of solvents. It is a drying oil inferior in drying qualities to linseed oil but superior in this respect to the semi-drying cottonseed oil. With proper treatment and with suitable driers soybean oil has been used successfully in certain kinds of paint, to the extent of 25 to 30 per cent of the oil required. It is being used in the production of lecithin and has proved satisfactory as a core binder for foundry work. It is also used in the manufacture of soft soap, enamels, lacquers, varnishes, cooking and salad oils, lard and butter substitutes, waterproof goods and various other products.

Soybean Meal.—Soybean meal or cake is a by-product of the oil extraction process. It is the residue after the oil has been extracted from the beans. The meal produced in Canada and the United States usually contains from 4·0 to 7·5 per cent of oil depending upon the method of extraction employed. The solvent method of extraction, used to some extent in the United States, may reduce the oil content of the meal to one per cent or less. Removal of the oil raises the percentage of protein, which accounts for the fact that soybean meal has a higher protein content than the seed itself. Being rich in protein soybean meal can be used to balance the grain rations of all classes of live stock. In feeding trials it has compared favourably with other high protein concentrates, such as linseed meal and cottonseed meal. Like the seed, it is deficient in minerals and requires a simple mineral mixture to be added when fed to poultry or hogs.

As a source of organic nitrogen in fertilizer mixtures for tobacco production soybean meal compared very favourably with cottonseed meal in experiments conducted by the Dominion Experimental Station, Harrow, Ont.

Soybean meal is being used also in the manufacture of flour, plastics, vegetable casein, glue, sauces, synthetic fibre and many other products.

Soybean Flour.—Soybean flour is made either from the whole beans or from soybean meal or cake. Flour made from the whole beans tends to become rancid on standing, due to the high content of oil, although it is now claimed that treatment by a special process has overcome this objection. Soybean flour is being used successfully in the making of bread, biscuits, muffins, pastry, chocolate bars, etc., and because of its composition improve the nutritive value of these products. The percentage of soybean flour used varies for each of the products mentioned. On account of its extremely low starch content soybean flour is especially valuable for diabetics.

Uses of the Soybean for Forage and Soil Improvement

The soybean may be grown as an annual or as a pasture crop; it may be ensiled or fed green; or it may be ploughed down to improve the fertility of the soil.

The soybean is one of the few annual legumes suitable for the production of hay and can therefore substitute for this purpose in the event of clover or alfalfa failure. In three to four months after seeding it produces hay equal in quality to alfalfa hay, suitable for feeding to all classes of live stock including poultry. Possessing a high content of digestible protein, it can be used to reduce the amount of costly concentrate feeds. It is usually recommended to feed it along

with other kinds of hay as it is claimed that there is a possibility of digestive trouble from feeding soybean hay alone. Seeding at the proper rate and harvesting at the right time will result in the production of good quality hay with fine stems and will largely overcome wastage which sometimes occurs in feeding soybean hay with a high percentage of coarse stems. The main objection in Canada to the use of soybeans for hay has been the difficulty of curing the crop. This may be avoided to some extent by the choice of varieties, using only those that will reach the hay stage during suitable curing weather.

ANALYSIS OF SOYBEAN HAY IN COMPARISON WITH OTHER IMPORTANT HAY CROPS[1]

Kind of Hay	Moisture	Ash	Crude Protein	Carbohydrates		Fat	Digestible Protein	Digestible carbohydrate equivalent[2]
				Crude Fibre	Nitrogen-free extract			
Soybean	8·4	8·9	15·8	24·3	38·8	3·8	11·2	44·0
Alfalfa	8·3	8·9	16·0	27·1	37·1	2·6	11·5	42·0
Red Clover	12·9	6·9	13·6	24·1	39·1	3·4	8·3	43·2
Timothy	12·5	5·4	6·8	28·3	44·3	2·7	3·3	44·7

[1]From "Soybean Utilization", by W. J. Morse, Farmers Bulletin No. 1617, U.S.D.A. 1932.

[2]The carbohydrate equivalent shown is the sum of the digestible crude fibre and nitrogen-free extract, plus 2·25 times the digestible fat.

ANALYSIS OF SOYBEAN HAY PRODUCED AT OTTAWA, ONT., 1937[1]

Variety[2]	Percent of Dry Matter						
	Protein (Nx6·25)	Crude Fat	Carbohydrates		Ash	Calcium	Phosphorus
			Nitrogen-free extract	Crude Fibre			
Mandarin	20·52	2·09	40·36	27·34	9·69	1·52	0·29
Wisconsin Black	20·46	3·14	36·04	31·10	9·26	1·63	0·27
Cayuga	19·10	2·13	38·66	31·02	9·09	1·33	0·27
O.A.C. No. 211	20·95	2·55	39·66	27·64	9·20	1·29	0·30
Kabott	18·73	2·31	42·98	26·32	9·66	1·42	0·28
Goldsoy	19·10	2·68	40·34	28·82	9·06	1·47	0·29

[1]Analyses made by the Division of Chemistry, Science Service, C.E. Farm, Ottawa, Ont.

[2]Each variety harvested when the beans had developed to approximately half-full size.

Soybean straw obtained from threshing has a definite feed value and can be fed to all classes of live stock. When used in addition to grain it has given better results than corn stover.

The soybean provides satisfactory pasture for live stock of all kinds, although several other annual crops might be used to better advantage for this purpose. When bad weather or other conditions interfere with harvesting the seed, it may be hogged off and used to supplement the corn ration. In parts of the United States it is a common practice to seed soybeans and corn together for pasturing both hogs and sheep.

The use of the soybean alone for ensilage is not recommended but high quality ensilage has been produced by a combination of soybeans and corn mixed in the proportion of about one part soybeans to three parts corn. The two crops can be grown together or they may be produced separately and mixed at the time of filling the silo. Harvesting will be easier and the recommended mixture better obtained where the two crops are grown separately.

The soybean crop may be used very effectively for soil improvement. For this purpose it is important that the plants shall be plentifully supplied with root nodules, as the result of proper inoculation, and that the crop shall be ploughed down not later than the flowering stage. Simply ploughing down the roots and stubble after the crop has been cut and removed as hay will not increase the nitrogen supply of the soil. It is necessary that the entire crop shall be turned under. Marked improvement in grain crops following soybeans, however, is frequently observable even when the crop has been harvested for hay or seed, a result which is due probably to the greater availability of nitrogen previously stored by the soybean roots and also the improved physical condition of the soil. This is particularly true after crops of soybeans which have been grown in cultivated rows.

Varieties

Soybean varieties are very numerous. They include many types and cover a wide range in maturity. In Manchuria, the home of the soybean, practically every district is said to have its own particular variety or strain. In the United States, it is reported that over 10,000 seed selections have been obtained and planted for study. In Canada hundreds of samples of seed have been secured from various sources but only a comparatively few of those tested have been found suitable for growing in this country.

Based upon results of tests conducted by the Dominion Experimental Farms the following varieties are considered the best of those available at present for production in Canada.

Increase field of Mandarin at maturity, grown at the Central Experimental Farm, Ottawa, Ont.

Variety	*Maturity*	*Colour of Seed*
Manitoba Brown	Very early	Brown
Pagoda	Very early	Yellow
Wisconsin Black	Early	Black
Kabott	Early	Yellow
Mandarin (Ottawa)	Medium early	Yellow
O.A.C. No. 211	Medium late	Yellow
Manchu	Late	Yellow (black hilum)
A. K. (Harrow)	Very late	Yellow (brown hilum)

Manitoba Brown is a semi-dwarf variety. Harvesting of the seed is difficult due to its short growth. It is essentially a seed type. Pagoda is a new variety originated at Ottawa from hybridization between Manitoba Brown and Mandarin. It is higher yielding than Manitoba Brown, is taller and approximately as early. It is better adapted for seed than for hay. Wisconsin Black may be used for hay or seed. Kabott is a recent variety produced by selection at Ottawa. It is satisfactory for either hay or seed production. Mandarin is a seed rather than a hay type although it can be used for both purposes. O.A.C. No. 211 produces a medium tall growth and is a good dual purpose variety, adapted for both hay and seed production. Manchu and A.K. are both tall growing varieties suitable for either hay or seed production.

YIELD.—In general, the yields of soybean varieties vary according to maturity, the later the variety the higher the yield. Tables 1 to 3 present the yields of hay and seed obtained in tests at Ottawa, Ont., Harrow, Ont., Charlottetown, P.E.I., Nappan, N.S., Fredericton, N.B., Lennoxville, Que., Brandon, Man., Morden, Man., Lethbridge, Alta., Agassiz, B.C. and Sidney, V.I., B.C.

TABLE 1.—SOYBEAN SEED PRODUCTION

Variety	Ottawa, Ont.[1]			Harrow, Ont.[2]		
	Date Ripe	Height	Bushels per Acre	Date Ripe	Height	Bushels per Acre
		in.	(15% moisture)		in.	(15% moisture)
Pagoda[3]	Sept. 2	30	26·77			
Kabott[3]	Sept. 9	33	29·00			
Mandarin (Ottawa)[4]	Sept. 20	31	31·08	Sept. 7	25	32·8
O.A.C. No. 211[4]	Oct. 5	32	23·66	Sept. 19	29	35·3
Manchu				Sept. 25	36	35·5
A.K. (Harrow)				Sept. 29	40	36·1

[1]Average; [3]3 years, 1936 to 1938; [4]5 years, 1934 to 1938. Average date of seeding, May 18. Row seeding.
[2]Averages, 10 years, 1927 to 1937 (1930 omitted). Average date of seeding, May 18. Row seeding.

TABLE 2.—SOYBEAN HAY PRODUCTION

Variety	Ottawa, Ont.[1]			Harrow, Ont.[2]		
	Date of Cutting	Height	Tons per Acre	Date of Cutting	Height	Tons per Acre
		in.	(15% moisture)		in.	(15% moisture)
Wisconsin Black	Aug. 13	44	2·57			
Kabott[3]	Aug. 13	42	2·90			
Mandarin (Ottawa)	Aug. 16	34	2·74	Aug. 12	26	2·56
O.A.C. No. 211	Aug. 20	39	2·77	Aug. 18	29	2·72
Manchu				Aug. 23	34	2·95
A.K. (Harrow)				Aug. 28	36	3·44

[1]Averages, 4 years, 1935 to 1938. [3]Kabott, 2 years, 1937 to 1938. Average date of seeding, May 23. Drill seeding.
[2]Averages, 9 years, 1929 to 1937. Average date of seeding, May 17. Drill seeding.

TABLE 3.—SOYBEAN HAY AND SEED PRODUCTION

CHARLOTTETOWN, P.E.I.

Variety	Hay[1]			Seed[2]		
	Date of cutting	Height	Yield per acre (15% moisture)	Date Ripe	Height	Yield per acre
		in.	tons		in.	bush.
Manitoba Brown	Aug. 25	25	2·28	Sept. 29	25	19·61
Wisconsin Black	Sept. 2	31	2·21	Oct. 7	31	18·65
Mandarin	Sept. 7	32	3·08	Oct. 6	32	25·31
O.A.C. No. 211	Sept. 11	33	3·11	Oct. 21	33	21·36
Manchu	Sept. 17	36	3·02			

[1]Averages, 3 years, 1936 to 1938. Date of seeding, May 29. Row seeding.
[2]Averages, 5 years, 1934 to 1938. Date of seeding, May 29. Row seeding.

FREDERICTON, N.B.

Variety	Hay[1]			Seed[2]		
	Date of cutting	Height	Yield per acre (15% moisture)	Date Ripe	Height	Yield per acre
		in.	tons		in.	bush.
Wisconsin Black	Aug. 27	27	2·07	Oct. 6	29	24·61
Mandarin	Sept. 4	27	2·23	Oct. 11	27	24·82
Manitoba Brown				Sept. 22	20	21·89
O.A.C. No. 211				Oct. 22	31	21·38

[1]Averages, 5 years, 1934 to 1938. Date of seeding, June 2. Row seeding.
[2]Averages, 5 years, 1934 to 1938. Date of seeding, May 29. Row seeding.

BRANDON, MAN.

Variety	Hay[1]			Seed[2]		
	Date of cutting	Height	Yield per acre (15% moisture)	Date Ripe	Height	Yield per acre
		in.	tons		in.	bush.
O.A.C. No. 211	Aug. 22	24	2·35			
Manchu (Disco)	Aug. 22	29	2·28			
Mandarin (Ottawa)	Aug. 22	24	2·50	Sept. 18	28	23·9
Wisconsin Black	Aug. 22	24	2·34	Sept. 12	27	22·6
Manitoba Brown				Sept. 4	24	19·8
Kabott				Sept. 9	27	22·4

[1]Averages, 6 years, 1933 to 1938. Date of seeding, May 12. Drill seeding.
[2]Averages, 2 years, 1937-1938. Date of seeding, May 10. Row seeding, 3 feet apart.

NAPPAN, N.S.

Variety	Hay[1]			Seed[2]		
	Date of cutting	Height	Yield per acre (15% moisture)	Date Ripe	Height	Yield per acre
		in.	tons		in.	bush.
Manitoba Brown	Sept. 10	.....	1·419	Sept. 26	17	18·7
Wisconsin Black	Sept. 10	.....	1·423	Oct. 3	21	20·1[3]
Mandarin	Sept. 20	.....	1·571	Sept. 13	22	21·8[4]
O.A.C. No. 211	Sept. 20	.....	1·738	Sept. 17	24	19·0[5]
Manchu				Oct. 18	28	11·9[6]

[1]Average, 1 year only 1934. Date of seeding, June 7. Drill seeding.
[2]Averages, 6 years, 1933 to 1938. Not fully matured, 1936[3], 1934 and 1936[4], 1934-35-36[5], 1933-34-35-36-37[6]. Date of seeding, May 27. Row seeding.

TABLE 3.—SOYBEAN AND HAY SEED PRODUCTION—*Continued*

LENNOXVILLE, QUE.

Variety	Hay[1]			Seed[2]		
	Date of cutting	Height	Yield per acre (15% moisture)	Date Ripe	Height	Yield per acre
		in.	tons		in.	bush.
O.A.C. No. 211	Aug. 30	30	3·16			
Manchu (Disco)	Aug. 30	36	2·94			
Wisconsin Black	Aug. 30	27	2·78	Sept. 22	23	24·94
Mandarin	Aug. 30	28	3·12	Oct. 6	25	23·86
Kabott[3]	Aug. 30	25	3·28	Sept. 30	22	23·35
Manitoba Brown				Sept. 16	18	21·26

[1]Averages, 5 years, 1934 to 1938. Date of seeding, May 27. Drill seeding.
[2]Averages, 5 years, 1934 to 1938. Date of seeding, May 27. Row seeding.
[3]Averages, 3 years, 1936 to 1938.

MORDEN, MAN.

Seed[1]

Variety	Days to mature	Height	Yield per Acre
		in.	bush.
Manitoba Brown	112	.....	21·21
Wisconsin Black	122	.....	24·91
Kabott[2]	121	.....	24·23
Mandarin	131	.....	26·49

[1]Averages, 4 years, 1935 to 1938. Row seeding.
[2]Grown in 1938 only.

LETHBRIDGE, ALTA.[1]

Variety	Hay[1]			Seed[2]		
	Date of cutting	Height	Yield per acre (15% moisture)	Date Ripe	Height	Yield per acre
		in.	tons		in.	bush.
Wisconsin Black	Early Sept.	27	2·56			
Mandarin	Early Sept.	29	3·32	Sept. 16	22	29·70[4]
Manitoba Brown	Early Sept.	22	2·32	Sept. 7	23	26·79
Kabott				Sept. 10	26	31·39
Pagoda				Sept. 5	23	27·26

[1]Under irrigation. Row seeding.
[2]Averages, 2 years, 1935-36.
[3]Averages, 2 years, 1937-1938.
[4]Mandarin did not ripen in 1938.

AGASSIZ, B.C.

Seed[1]

Variety	Date Ripe	Height	Yield per Acre (15% moisture)
		in.	bush.
Manitoba Brown	Sept. 2	21	16·99
Wisconsin Black	Sept. 4	27	20·19
Kabott	Sept. 12	27	21·73
Mandarin	Sept. 23	30	24·32

[1]Averages, 2 years, 1937-38. Date of seeding, May 5. Row seeding.

TABLE 3.—SOYBEAN AND HAY SEED PRODUCTION—*Concluded*

SIDNEY, B.C.

Seed[1]

Variety	Date Ripe	Height	Yield per Acre
		in.	bush.
Manitoba Brown	Sept. 26	26	13·9
Wisconsin Black	Oct. 4	25	8·5
Mandarin	Oct. 6	27	12·9

[1]Averages, 4 years, 1935 to 1938. Date of seeding, May 8. Row seeding.

VARIETAL ADAPTATION.—The adaptation of soybean varieties to the various parts of the Dominion is indicated to some extent in the data contained in tables 1 to 3. In Quebec and the Maritime Provinces, Mandarin can be depended upon to mature only in those sections most favoured with respect to both soil and season. Pagoda and Kabott should prove suitable in districts with less favoured conditions. In Ontario, Pagoda, Kabott, Mandarin, O.A.C. No. 211, and A.K. are being grown at present. Pagoda and Kabott ripen without difficulty at Ottawa and are adapted for production over a wide portion of eastern Ontario. Mandarin also matures regularly at Ottawa and may be grown in the more favoured districts of eastern Ontario. It is widely adapted to the regions of central and western Ontario. O.A.C. No. 211 is suitable for seed production in western Ontario generally, while A.K. is limited in adaptation to the extreme southwest portion of the province. Manchu may be used where a variety intermediate in maturity between O.A.C. No. 211 and A.K. is desired. The Prairie Provinces are limited almost entirely to the early maturing varieties, Manitoba Brown, Pagoda, Wisconsin Black and Kabott. Manitoba Brown and Pagoda being earlier, have much the wider adaptation, but where conditions warrant the use of a somewhat later variety, Wisconsin Black or Kabott may be used.

A.K. variety being harvested for hay at the Dominion Experimental Station, Harrow, Ontario.

Mandarin has been grown to maturity in southern Manitoba, but only under very favourable conditions can it be depended upon to produce normal crops of seed. In British Columbia, Kabott, Mandarin and O.A.C. No. 211 have been

matured and it is probable that these varieties may be adapted for seed purposes in certain favoured areas. Pagoda may be found suited to those sections of the province where early maturity is essential. At the Dominion Experimental Farm, Agassiz, B.C. the varieties Mandarin, O.A.C. No. 211 and Manchu were tested for hay and the same varieties in addition to Manitoba Brown, Wisconsin Black and Kabott have been tested for seed production. Regarding the hay tests the following observations were made; that while the varieties, especially Mandarin, gave some evidence of promise, the results as a whole were far from encouraging; that the possibility of success in growing soybeans for hay in the Fraser valley is very doubtful, owing to the unfavourable weather conditions which frequently prevail at the time of harvest, making the hay difficult or impossible to cure by ordinary methods. In the seed tests, Manitoba Brown, Wisconsin Black, Kabott and Mandarin have given the best results. Early maturity was found to be essential in order to avoid as far as possible difficulties of harvesting the crop due to heavy fall rains. It was concluded as the result of these tests that weather conditions in the Fraser valley during the fall season are generally speaking not ideal for the harvesting of soybean seed to best advantage.

Protein and Oil.—The percentage protein and oil content of soybean seed tends to vary inversely—the higher the protein the lower the oil and vice versa. Under the same conditions certain varieties are consistently high protein producers while others are uniformly high in oil production. The majority, however, approximate the average in the percentage of protein and oil.

The protein and oil content of seed produced in various parts of the Dominion is presented in table 4.

TABLE 4.—PROTEIN AND OIL CONTENT OF SOYBEAN SEED[1]

(Moisture-free basis)

Variety	Ottawa, Ont.[2]		Harrow, Ont.[3]		Nappan, N.S.[4]		Fredericton, N.B.[4]		Lennoxville, Que.[4]		Brandon, Man.[4]		Lethbridge, Alta.[4]	
	Protein	Oil	Protein	Oil	Protein	Oil	Protein	Oil	Protein	Oil	Protein	Oil	Protein	Oil
Manitoba Brown	37·9	19·1	.....	.....	34·0	20·7	39·5	20·6	38·0	20·6	.....	.....	41·7	15·7
Pagoda	33·0	23·1	.....	.....	32·7	23·4	36·4	21·4	34·0	24·5	39·7	21·1	36·0	20·5
Wisconsin Black	39·7	21·0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Kabott	37·8	19·8	.....	.....	36·9	21·0	39·4	20·7	37·4	22·1	45·3	18·5	44·1	16·5
Mandarin	36·7	20·8	42·1	19·6	30·3	23·9	33·1	23·0	33·5	24·3	.....	.....	44·5	17·6
O.A.C. No. 211	36·8	19·6	42·7	19·1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Manchu	36·3	20·7	42·2	18·2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
A.K.	.....	.....	41·3	19·4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[1]Analyses made by the Division of Chemistry, Science Service, Central Experimental Farm, Ottawa.
[2]Averages, 5 years, except Pagoda and Kabott (3 years), Wisconsin Black (2 years).
[3]Averages, 2 years.
[4]Average, 1 year.

It would seem that environmental factors have a definite effect upon the composition of soybean seed. Climatic factors, especially rainfall, appear to exert the greatest influence. There is some indication that low rainfall may favour the formation of protein and that higher rainfall may tend to reduce the protein content. Analyses given in table 4 show that seed grown at Lethbridge, Alta., Brandon, Man., and Harrow, Ont., which are located in areas of relatively low rainfall, contain appreciably more protein and slightly less oil than seed grown at Nappan, N.S., Fredericton, N.B., Lennoxville, Que., and Ottawa, Ont., which are more favourably situated with respect to moisture.

Size of Seed.—Size of seed is of some importance in seeding. Following is the average weight in grams of 1,000 seeds. The weights were obtained from seed grown at Harrow, Ont., during a period of several years:—

Manitoba Brown	199
Wisconsin Black	165
Mandarin	205
O.A.C. No. 211	225
Manchu	185
A.K.	162

Reference to tables 1 and 2 shows that size of seed is not related to either yield or maturity.

Colour of Seed.—Soybean seed colour is important only from the standpoint of commercial utilization, yellow seed being preferred to either brown or black.

Registration.—The following varieties are eligible for registration by the Canadian Seed Growers' Association: Manitoba Brown, Pagoda, Kabott, Mandarin (Ottawa), O.A.C. No. 211 and A.K. (Harrow).

Culture

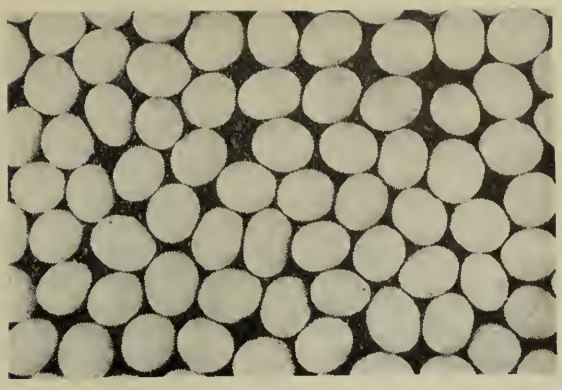
Soil Preparation.—Essentially the same as for corn. Fall ploughing is preferable, followed by a thorough working in the spring to provide a fine, smooth seed bed. Proper spring preparation will help materially in overcoming the weed menace later in the season.

Time of Seeding.—About the middle of May—a little earlier or a little later depending upon the locality and the season.

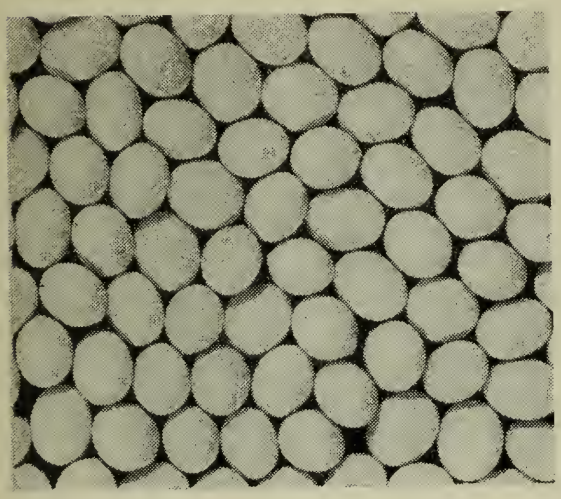
Inoculation of Seed.—For best results this is important, especially where the crop is being grown in a field for the first time. Commercial cultures for the inoculation of soybean seed are available and may be obtained from several sources. Satisfactory inoculation may be obtained by the use of sifted soil from a field which produced well inoculated soybeans the previous year, and mixing this with slightly moistened seed. Good results have also been reported by transferring soil from an inoculated field and spreading at the rate of about 250 pounds per acre.

Method of Seeding.—Seeding may be done either in rows 28 to 30 inches apart or in six-inch drills, similar to wheat or oats. For seed production the row planting is best. The rows may be spaced closer than the distance mentioned but should be sufficiently wide to permit of machine cultivation. Drilling solid is generally recommended for hay production. It produces hay with finer stems and if anything, slightly higher yields than row planting. Under no conditions, however, should this method of seeding be used if the land is known to be weedy. Soybeans grow very slowly at first, and heavy weed growth may ruin the crop entirely. Row seeding will require about 35 to 45 pounds of seed per acre, while drilling solid for hay requires about one and one-half to two bushels of seed per acre (one bushel=60 pounds).

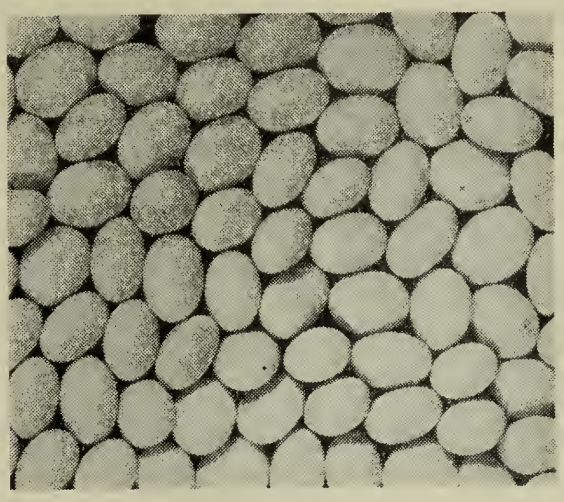
Pagoda (Yellow)



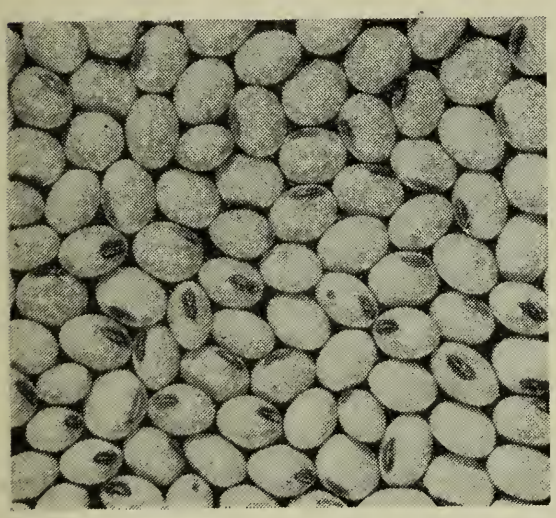
Kabott (Yellow)



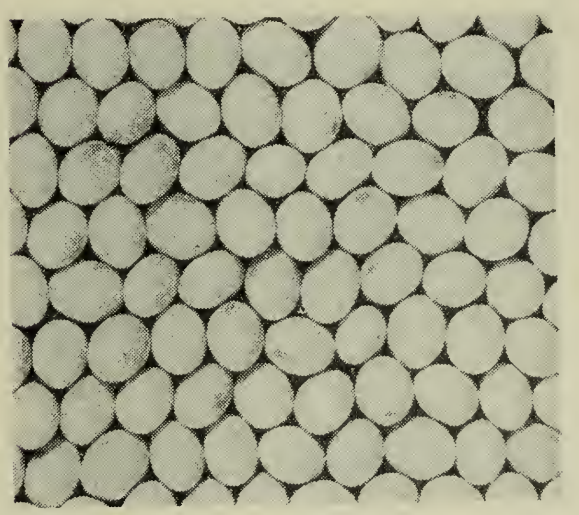
Mandarin (Yellow)



O.A.C. No. 211 (Yellow)



Manchu (Yellow-black hilum)



A.K. (Yellow-brown hilum)

Seed of six varieties of soybeans mentioned in this bulletin.

Depth of Seeding.—This depends upon the type and condition of the soil. One to two inches is usually satisfactory.

Cultivation.—If a crust forms at the surface of the soil before the beans are up the smoothing harrow should be used crosswise of the rows to assist the young seedlings to break through. It is a good practice to harrow lightly once or twice when the crop is from two to six inches high. This will greatly assist in

controlling weeds. Such cultivation should be done on sunny afternoons when the young seedlings are not easily broken. Commence row cultivation as early as possible and continue as with corn, as often and as long as is necessary for the control of the weeds. Practice level cultivation and avoid any tendency to produce ridges by throwing soil towards or against the rows. Ridged rows make harvesting difficult.

Harvesting.—In harvesting the crop for hay, cut when the pods are about half filled out, using the mower. This should be done in the morning after the dew is off. The crop is usually left in the swath for a day, or until the leaves are thoroughly wilted, then raked into windrows and allowed to cure or, after two or three days in the windrows, put into small cocks. The hay should be thoroughly cured before hauling and handled in such a way as to preserve the leaves as much as possible.

In harvesting the crop for seed, cutting is done after the leaves have dropped off. Practically all varieties lose their leaves at maturity. At this stage the pods will be brown and dry. The beans may still be rather soft, however, indicating a high moisture content. Under such conditions the crop should be allowed to remain standing until the beans have become quite firm and hard. If the pods shatter badly it is advisable to cut in the morning when they are damp with dew. Harvesting can be done with a grain binder, a self-rake reaper, a mower or a combine harvester. Unless the crop is so short that it is necessary to use the mower, soybeans are usually cut with the grain binder and handled in the same way as ordinary grain crops. The bundles should be made fairly small and not bound too tightly. They may be set up in small shocks and allowed to cure or they may be threshed immediately if the pods are dry and the seed is thoroughly ripe. After curing in the shocks soybeans can be housed or stacked. Since the mature soybean plants do not shed water readily themselves, it is necessary to use straw or other material to cover the stack, in order to prevent it from becoming water soaked.

Threshing.—The grain separator may be used to thresh the crop provided a few adjustments are made in order to prevent splitting of the seed. The speed of the cylinder must be reduced to about one-half, while the speed of the remainder of the machine must be maintained. This may be accomplished by doubling the size of the cylinder pulleys. It may also be necessary to substitute a blank plate or a block of wood in place of the concaves. Soybeans can also be threshed with an ordinary bean thresher.

Storage and Marketing

Careful handling of soybeans immediately after threshing is essential. Seed containing more than 12 to 14 per cent of moisture should not be stored in a deep bin but should be spread out so that it can be easily turned if heating occurs. It might even be advisable, if the quantity is not too large, to put the seed in sacks which can be moved from time to time to allow free circulation of the air. Improper storage may easily result in heating and moulding and impaired germination of the seed.

Marketing soybean seed is not complicated. The beans are used for three main purposes—for feed, for seed and industrial uses. Very little soybean seed is marketed for feed, and if used for this purpose it is usually fed at the farm on which it originates. Of the beans sold for seed, probably the greatest proportion is marketed directly by the growers themselves. Some seed is disposed of through the regular seed-houses, while the oil mills may sometimes arrange to supply the seed requirements of intending growers. Seed used for industrial purposes is at present marketed directly by the farmers.